INDOOR AIR QUALITY ASSESSMENT

Berkshire County Jail and House of Correction
Berkshire County Sheriff's Department
467 Cheshire Road
Pittsfield, Massachusetts

Prepared by:
Massachusetts Department of Public Health
Bureau of Environmental Health Assessment
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Background/Introduction

At the request of Officer Tom Mazzeo of the Berkshire County Sheriff's Department (BCSD), the Massachusetts Department of Public Health (MDPH), Bureau of Environmental Health Assessment (BEHA) conducted an indoor air quality evaluation at the Berkshire County Jail and House of Corrections (BCJ), 467 Cheshire Road, Pittsfield, Massachusetts. Concerns about indoor air quality and reoccurring respiratory infections prompted the indoor air quality assessment.

On May 7, 2003, Michael Feeney, Director of Emergency Response/Indoor Air Quality (ER/IAQ), BEHA evaluated the building. Mr. Feeney was escorted to various parts of the building by Officer Mazzeo and other BCJ staff. The BCJ is a secure, single story facility constructed in 2001. The indoor air quality assessment was conducted in offices and other areas occupied by BSCD staff work. The MDPH Division of Community Sanitation conducts inspections of correctional facilities pursuant to 105 CMR 451.000 Minimum Health and Sanitation Standards and Inspection Procedures for Correctional Facilities. This assessment is not an inspection conducted under 105 CMR 451.000, but is an evaluation of indoor air quality in work areas of the BCSD staff.

Methods

Air tests for carbon dioxide, temperature, relative humidity and carbon monoxide were taken with the TSI, Q-Trak ™, IAQ Monitor Model 8551.

Results

The BCJ has an estimated prisoner population of approximately 300 and a staff of 200. The tests were taken under normal operating conditions. Test results appear in Table 1.

Discussion

Ventilation

It can be seen from the tables that carbon dioxide levels were below 800 parts per million parts of air (ppm) in all areas sampled, indicating adequate ventilation in areas surveyed. However, please note that these measurements were taken in some areas with no occupancy (Table 1). With minimal occupancy and an adequate supply of fresh air by ventilation equipment, carbon dioxide levels in the building would be expected to be near outdoor levels. With an increased population in office areas at times of shift change, carbon dioxide levels would be expected to increase.

A heating, ventilation and air conditioning (HVAC) system provides ventilation. Fresh air is provided by rooftop-mounted air handling units (AHUs) (Picture 1). These AHUs are connected to ducts that supply fresh air to rooms through ceiling mounted air diffusers. By design, air diffusers are equipped with fixed louvers, which create airflow by directing the air supply along the ceiling to flow down the walls.

Local airflow to each air diffuser is controlled by a variable air volume (VAV) box (Picture 2). Each VAV box has a set of thermostat-controlled dampers that open or close depending on the temperature demand for a serviced area. Once the thermostat detects that the temperature has reached a predetermined level, the VAV box dampers close until heating or cooling is needed. VAV boxes also control the provision of fresh air to a serviced space. During times that the temperature of a space is adequate, the VAV box closes its damper and limits the amount of fresh air. In contrast, if the thermostat calls for the HVAC system to provide heat, the AHU fresh air intake damper would close to

increase the temperature of the air in the ductwork and occupied spaces. Airflow would be noted from the ceiling air diffusers because the VAV box dampers are open, but fresh air supply would be limited by the closing of the rooftop fresh air intake damper.

While it has the advantage of energy conservation and lower operating costs, VAV box systems may cause problems of insufficient outside air supply. For example, once the temperature requirement is met, airflow drops. Airflow can drop to zero in poorly performing HVAC systems (Plog, Niland and Quinlan, 1996). Please note that this condition may occur during times of outdoor temperature extremes (< 32^{o} F or >90^{o} F). Air monitoring was conducted on a day with comfortable outdoor conditions (72^{o} F). To ascertain whether zero airflow conditions exist, air monitoring during temperature extremes should be considered.

According to BCJ staff, air is returned back to rooftop AHUs by a ceiling plenum system. Exhaust ventilation is provided by infiltration of air into an above ceiling plenum, which returns air to the AHU. This system has no ductwork, but uses the entire above ceiling space to draw air back to the AHU. AHUs for prisoner areas are separate from the HVAC system serving staff office areas.

In order to have proper ventilation with a mechanical supply and exhaust system, these systems must be balanced to provide an adequate amount of fresh air to the interior of a room while removing stale air from the room. According to BCJ officials, the HVAC system was last balanced when the facility was opened (2001). It is recommended that existing ventilation systems be re-balanced every five years to ensure adequate air systems function (SMACNA, 1994).

The Massachusetts Building Code requires a minimum ventilation rate of 20 cubic feet per minute (cfm) per occupant of fresh outside air or have openable windows in each

room (SBBRS, 1997; BOCA, 1993) in office space. The ventilation must be on at all times that the room is occupied. Providing adequate fresh air ventilation with open windows and maintaining the temperature in the comfort range during the cold weather season is impractical. Mechanical ventilation is usually required to provide adequate fresh air ventilation.

Carbon dioxide is not a problem in and of itself. It is used as an indicator of the adequacy of the fresh air ventilation. As carbon dioxide levels rise, it indicates that the ventilating system is malfunctioning or the design occupancy of the room is being exceeded. When this happens a buildup of common indoor air pollutants can occur, leading to discomfort or health complaints. The Occupational Safety and Health Administration (OSHA) standard for carbon dioxide is 5,000 parts per million parts of air (ppm). Workers may be exposed to this level for 40 hours/week (OSHA, 1997).

The Department of Public Health uses a guideline of 800 ppm for publicly occupied buildings. A guideline of 600 ppm or less is preferred in schools due to the fact that the majority of occupants are young and considered to be a more sensitive population in the evaluation of environmental health status. Inadequate ventilation and/or elevated temperatures are major causes of complaints such as respiratory, eye, nose and throat irritation, lethargy and headaches. For more information concerning carbon dioxide, please consult Appendix I.

Temperature measurements were in a range of 74^{o} F to 76^{o} F, which were within the BEHA recommended comfort range. The BEHA recommends that indoor air temperatures be maintained in a range of 70^{o} F to 78^{o} F in order to provide for the comfort of building occupants. In many cases concerning indoor air quality, fluctuations of

temperature in occupied spaces are typically experienced, even in a building with an adequate fresh air supply.

The relative humidity in the building ranged from 34 to 43 percent, which was below the BEHA recommended comfort range in some areas. The BEHA recommends a comfort range of 40 to 60 percent for indoor air relative humidity. Relative humidity levels would be expected to drop during the winter months, due to heating. The sensation of dryness and irritation is common in a low relative humidity environment. Low relative humidity is a very common problem during the heating season in the northeast part of the United States.

Microbial/Moisture Concerns

Humidifiers were located in at least one BCJ office. Humidifiers should be cleaned regularly and be maintained as per the manufacturer's instructions to avoid bacterial/microbial growth (US EPA, 1991). Care should also be taken in the placement of humidifiers to avoid the repeated saturation of porous material(s), which may also lead to mold growth.

Other Concerns

A number of other conditions that can potentially affect indoor air quality were noted during the assessment. Of note is the location of the exhaust vents for the kitchen (Picture 3). These exhaust vents are located west of AHUs for the kitchen (Picture 4) and the large AHU for BCJ offices (Picture 5). Under certain wind conditions, cooking odors and products of combustion from the kitchen exhaust vents may be directed toward the fresh air intake hoods of these AHUs. The height of the boiler vents may also present a re-

entrainment concern during rare easterly wind conditions (Picture 5). With sufficient air velocity drawing air into the AHU, these products of combustion may be entrained by each AHU and distributed to office space.

Since the building office areas are entirely dependent on the HVAC system for provision of fresh air, caution should be taken in the use of materials that contain respiratory irritants. In particular, cleaning products containing volatile organic compounds (VOCs) (e.g. substance such as petroleum distillates, xylene) and alkaline materials [e.g. ammonia and sodium hypochlorite (bleach)] should be used in areas with adequate exhaust ventilation to remove odors from areas of application. VOCs and alkaline materials can be eye, nose and respiratory irritants. The following conditions can result in the aerosolization and exposure to these materials:

- Photocopiers: A number of offices have photocopiers. VOCs and ozone can be produced by photocopiers, particularly if the equipment is older and in frequent use. Ozone is a respiratory irritant (Schmidt Etkin, 1992). To help reduce excess heat and odors in these areas, BCJ personnel should ensure that local exhaust ventilation is activated while equipment is in use. If local exhaust ventilation is not feasible, relocating photocopiers to areas with a large air volume to dilute pollutants produced by this equipment is recommended.
- Dry erase materials: Some offices contained dry erase boards and dry erase markers. Materials such as dry erase markers and dry erase board cleaners may contain VOCs, (e.g. methyl isobutyl ketone, n-butyl acetate and butyl-cellusolve) (Sanford, 1999), which can be irritating to the eyes, nose and throat.

Of note are several vocational education areas that use a variety of irritating and/or flammable chemicals.

- VE 04 Print Shop: Inside the print shop are a number of printers that use VOC containing materials. Inks, washes and hand cleaners containing VOCs are used in this area. No local dedicated exhaust ventilation exists for any of the printers. Both OSHA and the American Conference of Governmental Industrial Hygienists (ACGIH) have established Permissible Exposure Limits (PELs) (OSHA, 1997) and Threshold Limit Values (TLVs) (ACGIH, 2002) for various VOCs. It appears that the return vent for the general ventilation system is the sole exhaust vent in this room (Picture 6). In this configuration, pollutants created by use of printing machinery can aerosolize VOCs, which are then be drawn into the AHU and may be distributed to other areas serviced by the vocational education area's HVAC system. The ACGIH has recommended standards for local exhaust ventilation for specific operations such as printing presses (ACGIH, 1998). If this is not practicable, personal protective equipment fit-tested for each individual should be considered.
- VE01 General Utility Workshop: This area contained a grinder. As grinding machines grind or cut metal, heated metal particles, or fume, is produced and aerosolized. With the ceiling exhaust vent deactivated during grinding, metal fumes can move from this area into the hallway through the space under the door. Metal fumes are respiratory irritants. Both OSHA and ACGIH have established PELs (OSHA, 1997) and TLVs (ACGIH, 2002) for various metal fumes. An evaluation of the contents of the material-producing fume must be done in order to ascertain whether PEL or TLV applies in this situation. This evaluation, as well as

an evaluation of the concentration of materials being aerosolized, should be conducted by a certified industrial hygienist. Please note these exposure standards apply to healthy adult employees in the workforce. The ACGIH has recommended standards for local exhaust ventilation for specific operations such as surface grinders, grinding wheels, lathes and metal band saws (ACGIH, 1998). If standards are not practicable, individual personal protective equipment that is fit-tested for each individual should be considered.

- VE02 Carpentry Shop: Spaces, noted at the bottom and between hallway doors, can allow for sawdust and other pollutants to migrate from the shop to the hallway. The shop does not have a ducted collection system for dust generating machinery (e.g. saws, sanders). It appears that wood particles are filtered through a portable collection unit (Picture 7). It is recommended that wood dust be removed from the environment at the point of generation using a dust collection system to prevent dust aerosolization. Wood dust can be irritating to the eyes, nose, throat and respiratory system.
- Flammable Chemical Storage in VE Area: Flammable materials in shops are stored in flameproof cabinets (Picture 8). An exhaust vent was installed to each flameproof cabinet. The National Fire Prevention Association (NFPA) does not require venting in flammable storage cabinets, however, if venting is done, it must be vented directly outdoors and in a manner that does not compromise the specific performance of the cabinet (NFPA, 1996). If air backflow from outdoors into the cabinet through the venting occurs, off-gassing chemicals can be forced from the flammable storage cabinet into the storeroom. Proper design of exhaust vents should prevent air backflow into the cabinet. The installation of the exhaust vents

has compromised the fire integrity of the cabinets. Copper pipes were connected to each flameproof cabinet to serve as vents (Picture 9). Each vent pipe is installed through the BCJ exterior wall (Picture 10). No air backflow device could be identified in these vent pipes. In their current condition, these pipes can provide an oxygen supply to the interior of each flameproof cabinet.

Also of note is the number of holes in interior walls of VE shops (Pictures 10 & 11). As discussed in the Ventilation Section of this report, the return system for the building is a plenum type system. In this configuration, the area above the ceiling becomes depressurized as the AHU operates. Depressurization causes air and airborne pollutants to be drawn into the plenum system through these holes and become redistributed to other areas served by the AHU.

Conclusions/Recommendations

The conditions observed in the BCJ raise a number of indoor air quality issues. The location of some AHUs in an area that is predominantly downwind from kitchen exhaust vents provides an opportunity for kitchen odors to be distributed to other areas of the building. In addition, the nature of the building as a corrections facility resulted in a design that is entirely dependent on the mechanical ventilation system to provide for the comfort of occupants. This dependence on the ventilation system can make the building prone to a build up of environmental pollutants indoors produced through normal activities (as well as in shops), which can account for symptoms of eye, nose and throat irritation. In order to address the conditions listed, the recommendations to be made to improve indoor air quality in the building are divided into **short-term** and **long-term** corrective measures. The short-term recommendations can be implemented as soon as practicable. Long-term

recommendations are more complex and will require planning and resources to adequately address the overall indoor air quality concerns within the building. In view of the findings at the time of the visit, the following conclusions and recommendations are made:

Short Term Recommendations

1. Seal the return vent in the print shop (Picture 6). Install a rooftop exhaust vent system in the print shop ceiling, similar to systems in rooms VE 01 and VE 02.
2. Disconnect the flammable storage cabinet from the PVC pipes and reseal the cabinet with its original bunghole caps.
3. Seal all holes in interior walls of VE shops to prevent pollutants from penetrating into the ceiling plenum.
4. Examine current Material Safety Data Sheets (MSDS) for all products that contain hazardous materials and are used within the building, including office supplies, in conformance with the Massachusetts Right-To-Know Law, M.G.L. c. 111F (MGL, 1983). Use non-VOC and alkaline containing materials indoors where feasible.
5. Seal door frames in shop hallway doors. Install weather-stripping and door sweeps along door/doorframe seams to serve as a barrier.
6. For buildings in New England, periods of low relative humidity during the winter are often unavoidable. Therefore, scrupulous cleaning practices should be adopted to minimize common indoor air contaminants whose irritant effects can be enhanced when the relative humidity is low. To control for dusts, a high efficiency particulate arrestance (HEPA) filter equipped vacuum cleaner in conjunction with wet wiping of all surfaces is recommended. Drinking water during the day can

help ease some symptoms associated with a dry environment (throat and sinus irritations).

7. At minimum, operate the rooftop exhaust vent while using grinder.
8. Clean and maintain humidifiers as per the manufacturer's instructions, or more frequently if needed to prevent microbial growth.

Long Term Recommendations

1. Consider extending the terminus for the boiler stacks to a sufficient height above the fresh air intake hood of the nearby AHU (Picture 5).
2. Consider extending the terminus for the kitchen exhausts vents at a level above the fresh air intakes for nearby AHUs. If not feasible, consider installing a solid barrier between fresh air intakes and exhaust vents on roof to direct kitchen exhaust odors away from the AHU fresh air intakes.
3. Examine the feasibility of installing local exhaust ventilation for printers in the print shop.
4. Examine the feasibility of installing local exhaust ventilation for the metal grinder.
5. Examine the feasibility of installing an exhaust vent over the wood dust collector to capture respirable dust and vent outdoors.

References

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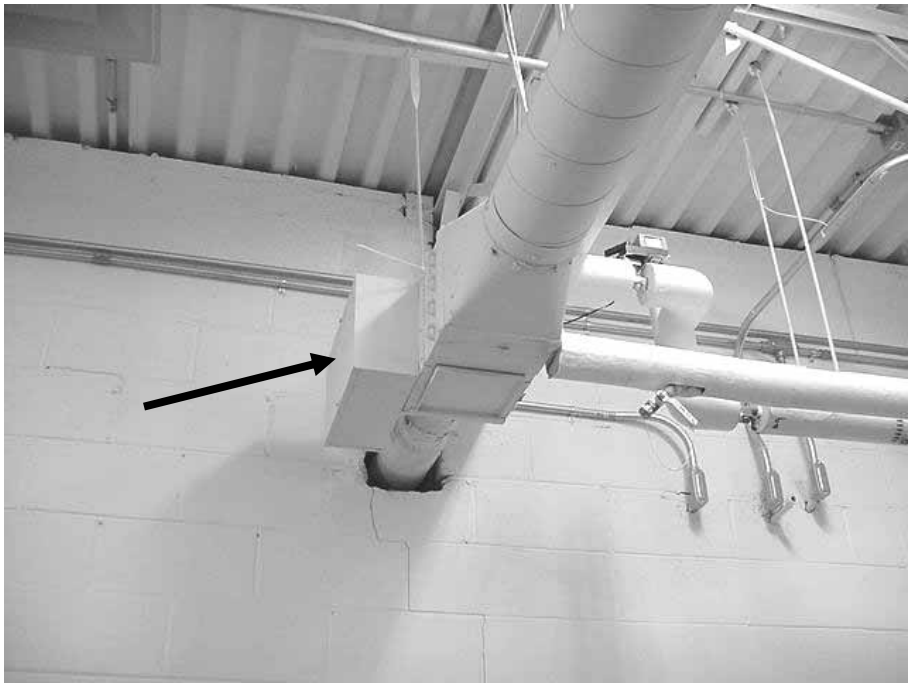
US EPA. 1991. Indoor Air Facts No. 8 Use and Care of Home Humidifiers. US Environmental Protection Agency, Office of Air and Radiation, Office of Research and Development, Washington, DC. February 1991.

Picture 1

Rooftop AHU

Picture 2



VAV Box

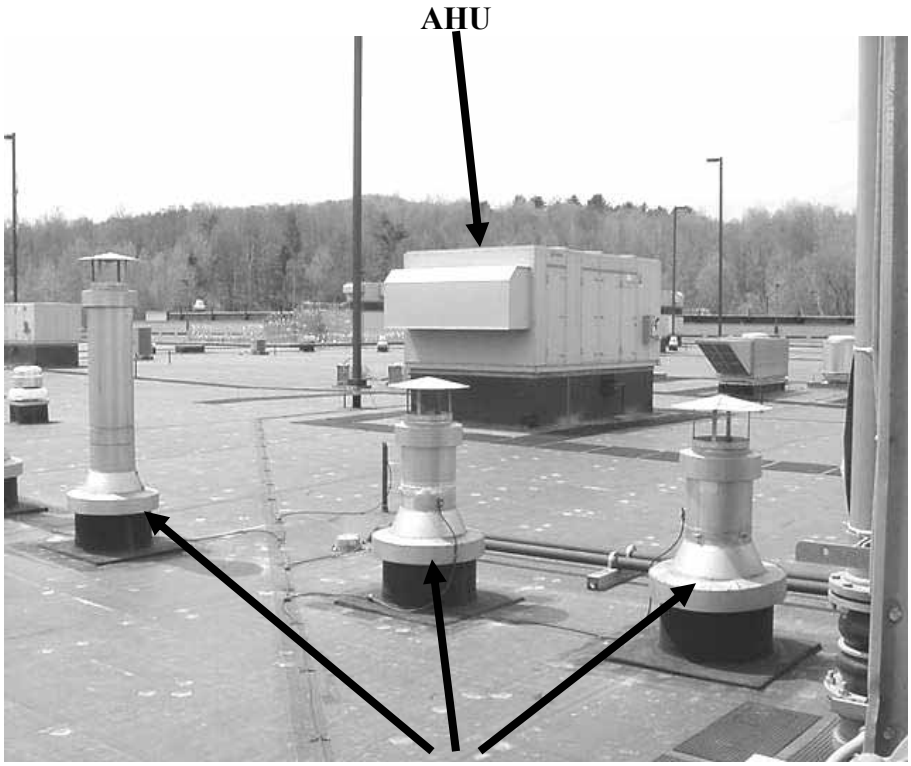
Picture 3

Kitchen Exhaust Vents On Roof

Picture 4

AHUs Are East Of the Kitchen Exhaust Vents

Picture 5



Large AHU for BCJ Offices, East of Kitchen Exhausts, Note Height of Boiler Vents on Foreground

Picture 6

Exhaust Vents in Print Shop VE 04

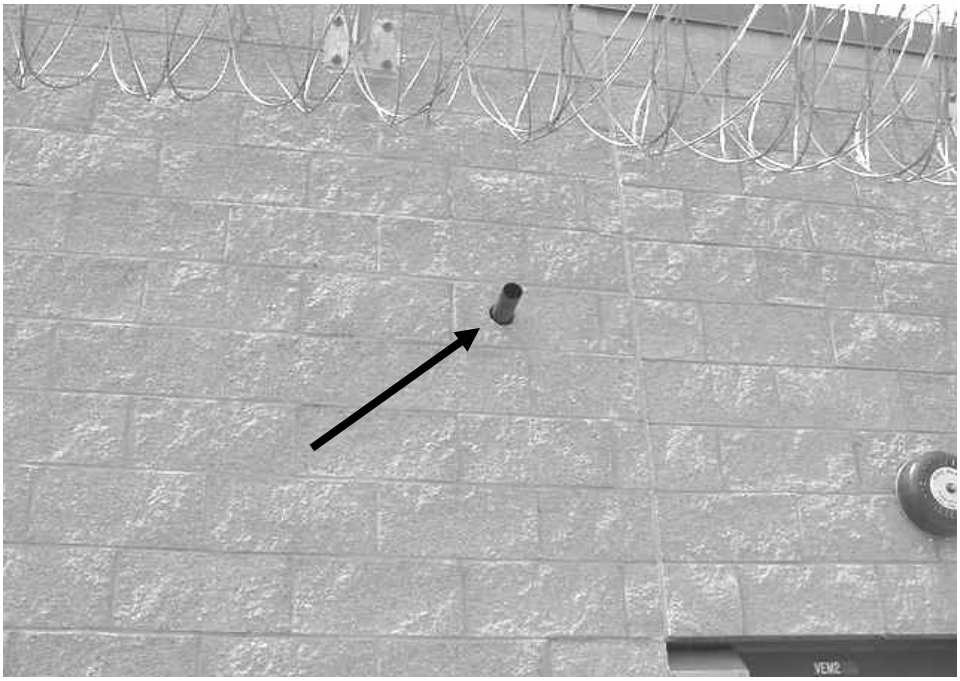
Picture 7

Wood Dust Collector

Picture 8

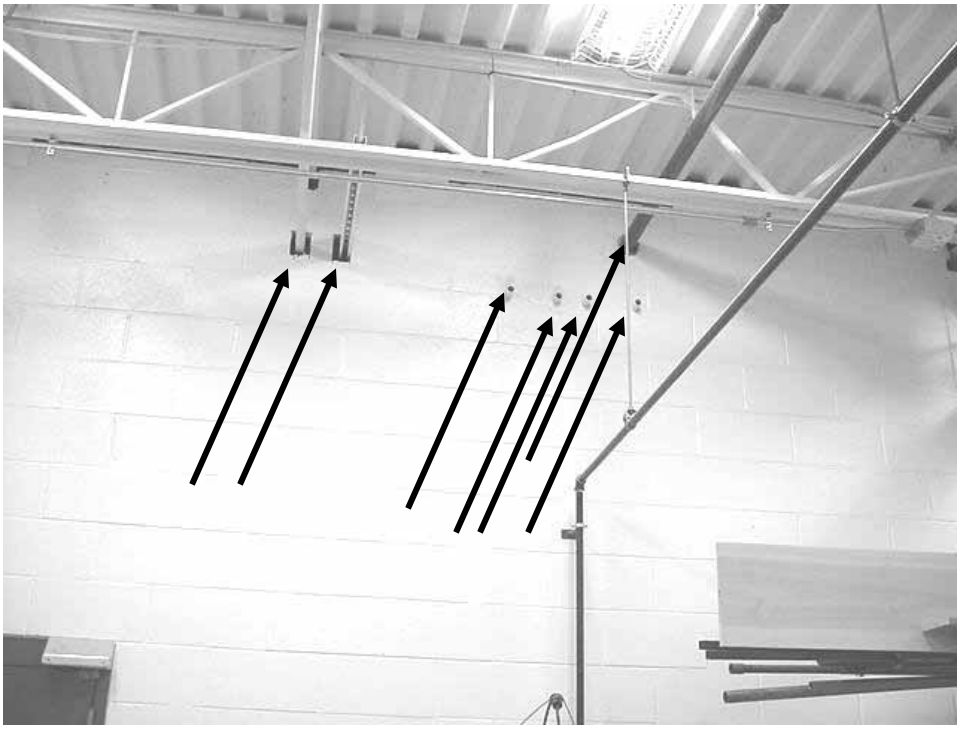
Flameproof Cabinet, Note Copper Pipe Serving As Exhaust Vent

Picture 9



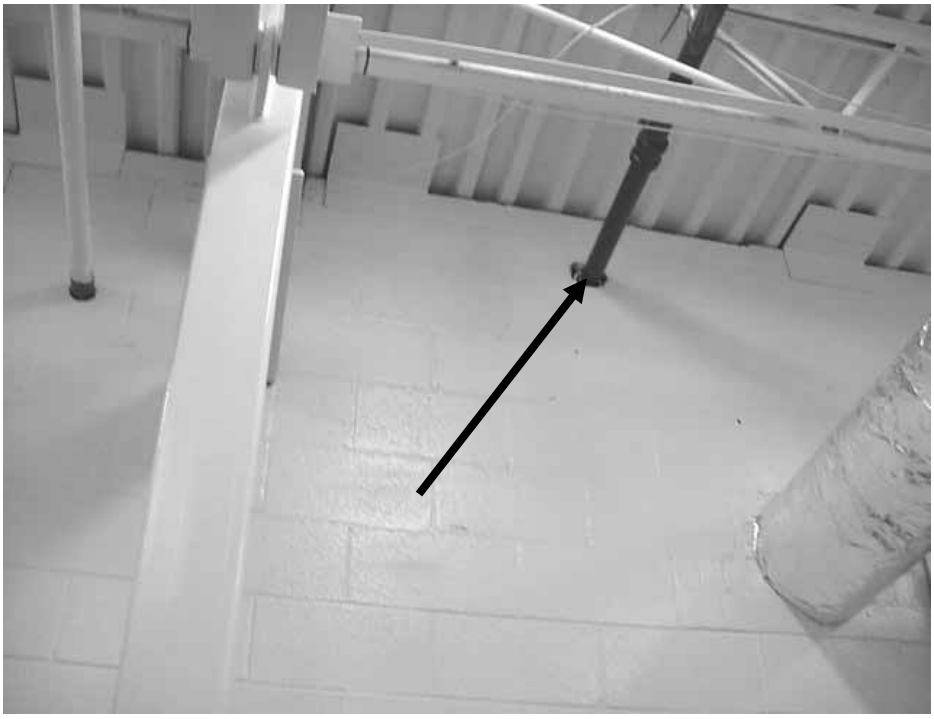
Flameproof Cabinet Exhaust Vent Pipe Terminus, Exterior Wall

Picture 10



Holes in Interior Wall, VE Room

Picture 11



Hole in Interior Wall, VE Room

TABLE 1

Indoor Air Test Results – Berkshire County Jail, Pittsfield, Massachusetts May 7, 2003

Location	Carbon Dioxide (*ppm)	Temp (°F)	Relative Humidity (%)	Occupants in Room	Windows Openable	Ventilation		Remarks
						Supply	Exhaust	
Background	368	68	49					
Lobby	526	74	43	1	N	Y	Y	
CC 12	479	76	37	0	N	Y	Y	4 computers computer equipment smell
CC 14	431	75	36	1	N	Y	Y	Photocopier odor
CC 10	419	74	36	0	N	Y	Y	Dry erase board
CC 1, Central Control	465	75	36	2	N	Y	Y	10 monitors
1A 07	624	74	38	2	N	Y	Y	Door open
1A 08	634	75	38	0	N	Y	Y	Door open
1A 05	456	75	36	0	N	Y	Y	Dry erase board
1A 11	565	75	37	0	N	Y	Y	Door open Chewing tobacco odor
HS 12	567	74	37	1	N	Y	Y	Door open

*** ppm = parts per million parts of air**

Comfort Guidelines

Carbon Dioxide -	< 600 ppm = preferred
	600 - 800 ppm = acceptable
	> 800 ppm = indicative of ventilation problems
Temperature -	70 - 78 °F
Relative Humidity -	40 - 60%

TABLE 1

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						Supply	Exhaust	
HS 11	463	74	37	0	N	Y	Y	Door open
HS 08	467	75	37	0	N	Y	Y	Door open Humidifier
HS 20	536	75	37	0	N	Y	Y	Photocopier odor Door open
HS 27	436	74	36	1	N	Y	Y	Door open Dry erase board, purfume odor
HS 24 Library	442	74	36	1	N	Y	Y	Door open
HS 25	432	74	36	1	N	Y	Y	Door open Dry erase board
VE 04 Paint Shop	503	76	36	1	N	Y	Y	2 photo printers, hole in ceiling, laminator, citrus cleaner, no local exhaust
VE 03	466	75	35	0	N	Y	Y	
VE 02	465	76	35	0	N	Y	Y	Dedicated exhaust vent on roof, flame proof cabinet, wood dust collector

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						Supply	Exhaust	
VE 01	485	76	35	0	N	Y	Y	Grinder, open pipes in interior wall, dedicated exhaust vent on roof
H Pod Day Room	435	74	35	13	N	Y	Y	
MA 01	462	75	34	2	N	Y	Y	Dry erase board
MA 07								Flame proof carpeting UV

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